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THE BUCKTHORN APHID.

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BULLETIN 317

THE BUCKTHORN APHID.[1]

(Aphis abbreviata Patch).[2]

By Edith M. Patch

Small aphids, sometimes green and sometimes yellow, annually abundant on a wide range of vegetation, have for years perplexed the writer. They all resemble each other in having sensoria on the third, fourth and often on the fifth segment of the antenna of the winged form, in having usually three or four pairs of caudal hairs, and in having pale cornicles and cauda in the wingless forms; but there is variation enough to make the problem whether they were one species or many a query which could not be answered until the life cycle was worked out. It was not until the summer of 1923 that I made sure that a single species overwintering on buckthorn *(Rhamnus)* produced winged forms in the spring that migrated to vegetable gardens and flower gardens and weeds and produced the whole number of these troublesome summer aphids agreeing in those structural characters just indicated. This throws the buckthorn aphid, as progenitor for a very troublesome brood, into an economic perspective with which hitherto it has not been viewed; and makes desirable a statement with reference to its activities.

Life Cycle.

The buckthorn aphid passes the winter in the egg stage on the branches of buckthorn, usually tucked about the leaf buds. In the spring these eggs hatch into females only—the "stem mothers" which without mating produce, after the manner of aphids, a considerable brood of living young. These young, also all females, attain their full growth by feeding as did the parent form, on the leaves of buckthorn. Some of this second spring generation are wingless, some are winged. The wingless forms

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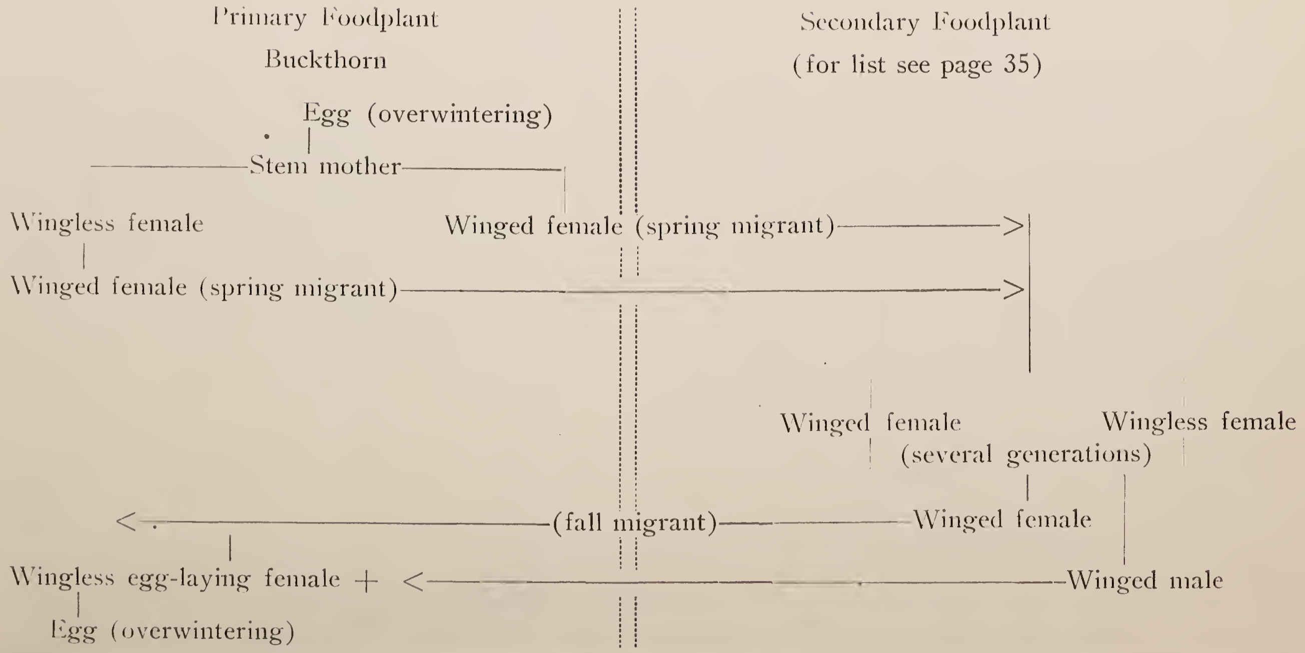
[1] Papers from the Maine Agricultural Experiment Station: Entomology No. 114.

[2] See also page 42 for "the names of the buckthorn aphid."

LIFE CYCLE OF THE BUCKTHORN APHID.



remain on the buckthorn while their winged sisters migrate to nasturtium *(Tropaeolum)*, dock, potatoes, and a multitude of other plants, thence to disperse in later generations to still others. The wingless females of the second buckthorn generation produce chiefly young which become winged and follow their migrant aunts to summer (secondary) foodplants. On these various plants[3] a succession of female generations are born, for the most part wingless but still with a fair proportion of winged forms which serve to scatter the species to such different plants as meet the food requirements of this aphid. Late in the summer and in the fall two forms with a special mission are developed, one winged and known as the "fall migrant," and one wingless. The wingless females of this fall generation give birth to young which develop into winged males which fly to the buckthorn. The fall migrants have, previous to the flight of the males, already arrived at the buckthorn where they give birth to very small egg-laying females which attain their growth by the time the males appear. These wingless oviparous females and the winged males mate and subsequently the overwintering egg is deposited on the buckthorn twigs usually about the leaf buds. This brings us back to the starting point of the cycle, as it is from these overwintering eggs that the "stem mothers" hatch in the spring. The life cycle is outlined in diagram form on page 30.

MIGRATION AND DISPERSAL HABITS.

As has been stated in the previous section, the buckthorn aphid migrates away from the buckthorn in the spring and returns in the fall. In 1923, at Orono, the greater part of the spring migration took place the last week in June, though some of the spring migrants had taken flight previously and a few stragglers remained until a later date. This hegira was almost a total one; but an occasional spring migrant settled on fresh newly growing leaves of buckthorn establishing a summer colony there. Such colonies remained on the buckthorn and were observed July 19, August 3 and August 13. All the spring migrants but a few stragglers, however, sought different plants; and the list on pages 35 to 39 gives a record of such plants on which summer colonies had been established, together with the date of collection. None of the collections indicated were "accidental" or "stray" specimens, as none were included in the list except such as were taken from good colonies well established on the foodplant recorded. On such foodplants the colonies remaining during the summer were for the most part composed of wingless females though, especially in cases of heavy infestation, numerous winged females were developed. These took flight for fresher feeding opportunities and served to disperse the summer colonies widely.

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[3] For Maine list see page 35.

By September 5, winged females, however, began to be excessively numerous. These were for the most part fall (or "return") migrants which without stopping, after the development of their wings, to feed on the summer foodplant flew back to the buckthorn which the spring migrants had deserted late the previous June. The height of this flight was about the middle of September.

At that time the fall migrants were found to be numerous on the buckthorn where they settled on the under surface of the leaves and produced large colonies composed exclusively of small wingless females. These small females differ from all the other generations in being oviparous instead of viviparous, that is they are the only individuals in the whole cycle of the species that produce eggs instead of living young. When these oviparous females were mature they were found by winged males that had developed on the summer foodplant and migrated to the buckthorn to mate with the last generation of females of the season. This is the only generation depositing eggs and the only time in the life cycle of the species that males appear. After the middle of September for a month and more the oviparous females could be found depositing their overwintering eggs on the buckthorn twigs, tucking them around the leaf buds. The last such collection in 1923 was made October 19 and they could doubtless have been found later if observations had been made subsequent to that date.

ECONOMIC IMPORTANCE.

A nuisance to the landscape gardener. In so far as the buckthorn itself is concerned, the economic status of the buckthorn aphid is probably of more interest to the landscape gardener than to the agriculturist. Certainly a heavy spring infestation by this insect can turn a buckthorn hedge into an unsightly object. As relates a long list of the secondary or summer foodplants, the grower of flowering plants is especially troubled; and the person who tries to feature nasturtiums (Tropaeolum) in the vicinity of a buckthorn tree or hedge has arranged matters much more for the welfare of the aphids than of his flower garden. It may prove important to growers of garden plants whether in small grounds or on a large estate to make their plans with a view to discouraging the buckthorn aphid, rather than (as is often done at present) inviting this little pest to enjoy some favorite menu set forth in most appetizing courses.

A pest in the vegetable garden. Leaving the perhaps most spectacular feature of the case against the buckthorn aphid, we come to the question as to what its actual feeding injuries to economic vegetables amount to. In the vicinity of Orono, this species out numbers the better known melon aphid *(Aphis gossypii)* as a cucumber and squash pest. As a potato insect it is generally outranked throughout the State by the spinach aphid *(Myzus persicae)* and still more by the potato aphid *(Macrosiphum solanifolii.)* However in 1923 in a certain laboratory plot of potatoes at Presque Isle, the buckthorn aphid outnumbered those other two species combined. It is yet too early in our acquaintance with this aphid to place properly its economic status in different parts of the country.

The fact that this insect seems to thrive best during the summer in shade or moist situations makes its habits on certain plants quite different from its behavior on others. Thus in some situations it will be found thickest on the exposed most rapidly growing part of the plant, and the terminal stem will be entirely covered with its colonies. In other places, as in a sun exposed potato field, this aphid seeks the under side of the leaves almost exclusively, especially the older lower leaves; and often those touching the ground will be found packed with these aphids when the stem and upper leaves are practically free. This is in marked contrast with the larger potato aphid *(Macrosiphum solanifolii)* which attacks the upper part of the plant in preference to the lower.

A carrier of plant disease. It is not alone on the basis of direct feeding injury that the economic damage by aphids can be judged. They must also be reckoned with as possible carriers of plant diseases.

The fact that two other species of aphids *(Macrosiphum solanifolii* and *Myzus persicae)* had been found, under experimental conditions, to transmit potato mosaic[4] laid the buckthorn aphid open to suspicion in the same connection; and experiments conducted in 1923[5] proved this species also to be capable of mild mosaic transmission in potatoes. Inasmuch as the former species have also been proved to be transmitters of other degeneration diseases in addition to several types of mosaic[6] there is reason to expect proof eventually that the buckthorn aphid is a transmitter of more degeneration diseases than mosaic of the mild type.

The possibility of mosaic transmission is not restricted to the Potato Family. Among the summer foodplants of this aphid in Maine alone, at least seven other families are represented each containing plants that are subject to one or more types of aphid-transmitted mosaic (Grass, Goosefoot, Mustard, Rose, Pulse, Gourd, and the Composite Families).[7] Again, the Maine summer foodplants include, in addition to potato, six genera (Beta, Brassica, Phaseolus, Trifolium, Nicotiana, and Cucumis) and five species (beet, bean, clover, tobacco, and cucumber) that are subject to aphid-transmitted mosaic. The chances are therefore, that this insect plays a considerable role in the spread of plant disease.

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[4] Schultz, E. S., Folsom, Donald, Hildebrandt, F. Merrill, and Hawkins, Lon A. Investigations on the mosaic disease of the Irish potato. Jour. Agric. Res. 17:247-273. 1919.

Schultz, E. S. and Folsom, Donald. Transmission of the Mosaic Disease of Irish Potatoes. Jour. Agric. Res., 19:315-337. 1920. See p. 326-328.

Folsom, Donald. Potato Mosaic. Me. Agric. Exp. Sta. Bul. 292. 1920. See p. 169-174.

[5] Schultz, E. S. and Folsom, Donald. Transmission and dissemination experiments with degeneration diseases of Irish potatoes. Observations in 1923. Tentative manuscript.

[6] Schultz, E. S. and Folsom, Donald. Leafroll, net-necrosis, and spindling-sprout of the Irish potato. Jour. Agric. Res. 21:47-80. 1921. See p. 53-59.

Folsom, Donald. Potato Leafroll. Maine Agric. Exp. Sta. Bul. 297. 1921. See p. 46-48.

Schultz, E. S. and Folsom, Donald. Transmission, variation, and control of certain degeneration diseases of Irish potatoes. Jour. Agric. Res. 25:43-117. 1923. See p. 501 51-52, 58-60, 61, 68-69, 74-76.

Folsom, Donald. Potato spindle-tuber. Maine Agric. Exp. Sta. Bul. 312. 1923. See p. 35-36.

[7] Nelson, Ray. Transference of the bean mosaic virus by *Macrosiphum solanifolii.* Science, 56:342-344. 1922.

Robbins, W. W. Mosaic disease of sugar beets. Phytopathology, 11: 349-365. 1921. See p. 360-363.

A summary of information pertaining to transmission of mosaic by aphids is given by Dickson, B. T. Studies concerning mosaic diseases, Macdonald College, P. O., Que., Canada. Tech. Bul. no. 2, 1922. See p. 78-82.

FOODPLANTS IN MAINE.

As this species has a very wide range of summer foodplants, it will probably be many years before a complete list can be made. Those given in this bulletin are exclusively Maine records of this insect as collected or reared either by or under the direction of the writer, who personally determined all the material indicated. With a few exceptions the collections are those of the season, 1923.

Since the species is found to have such a wide range of food in one locality, it is certain in other parts of the world to have many other plants on its menu.

WATER-PLANTAIN FAMILY.

Alisma plantago-aquatica L. 2-23 sub. 1c, July 11; 398-23, Aug. 6; 494-23. Aug. 18; 123-10, Sept. 14.

Sagittaria latifolia Willd. Arrow-head. 120-23, July 13; 2-23 sub. 1e; July 28: 408-23, Aug. 6; 414-23, Aug. 6; 2-23 sub. 1a, July 3; 2-23 sub. 1b. July 11; 2-23 sub. 1d, July 16.

GRASS FAMILY.

Agropyron repens (L) Beauv. Couch grass. 202-23, July 19.

PICKEREL-WEED FAMILY.

Pontederia cordata L. Pickerel-weed. 2-23 sub. 1f, Aug. 11, 2-23 sub. 1g, Aug. 15; 2-23 sub. 1h, June 5 to Aug. 24.

BUCKWHEAT FAMILY.

Fagopyrum esculentum Moench. Buckwheat. 131-23, July 16; 263-23, July 26; 311-23. July 31; 488-23, Aug. 18; 64-05, Aug. 31.

Polygonum aviculare L. Knotweed. 206-23, July 20.

Polygonum convolvulus L. Black Bindweed. 80-23, July 11; 369-23, Aug. 3.

Polygonum hydropiper L. Common Smartweed or Water Pepper. 200-23, July 19; 188-23, July 19.

Polygonum lapathifolium L. 306-23, July 30.

Polygonum sachalinense Schmidt. Sacaline. 36-23, July 5; 122-23, July 13; 125-23, July 16; 173-23, July 19; 592-23, Sept. 5; 610-23, Sept. 19.

Polygonum sagittatum L. Arrow-Leaved Tear Thumb. 334-23, July 31.

Polygonum zuccarinii Small. 255-22a, August 16.

Rumex acetosella L. Field or Sheep Sorrel. 124-23, July 16; 381-23, Aug. 3.

Rumex crispus L. Yellow Dock. 40-23, July 5; 91-23, July 11; 126-23, July 16; 308-23, July 30; 316-23, July 30; 320-23, July 31; 560-23, Sept. 6; 636-23, Sept. 29; 318-23, July 31.

Rumex obtusifolius L. Bitter Dock. 298-22, Aug. 29.

GOOSEFOOT FAMILY.

Beta vulgaris Moq. Common Beet. 452-23, Aug. 13.

Chenopodium album L. Lamb's Quarters, Pigweed. 35-23, July 5; 171-23, July 19; 193-23, July 19.

AMARANTH FAMILY.

Amaranthus retroflexus L. Pigweed. 192-23, July 19; 283-23, July 26.

PINK FAMILY.

Stellaria media (L). Cyrill. Common Chickweed. 281-23, July 26.

PURSLANE FAMILY.

Portulaca oleracea L. Common purslane. 450-23, Aug. 13.

CROWFOOT FAMILY.

Ranunculus acris L. Tall Crowfoot or Buttercup. 117-23, July 13; 123-23, July 16; 235-23, July 24; 548-23, Sept. 5.

BARBERRY FAMILY.

Berberis thunbergii DC. 397-23, Aug. 6.

MUSTARD FAMILY.

Brassica arvensis (L). Ktze. Charlock. 77-23, July 11; 328-23, July 31.

Brassica oleracea Linn. Cabbage. 197-23, July 19.

Capsella bursa-pastoris (L) Medic. Capsella, Shepherd's Purse. 81-23, July 11; 203-23, July 19; 257-23, July 26; 559-23, Sept. 6; 133-21, July 25; 616-23, Sept. 26.

Radicula palustris (L). Moench. Marsh Cress. 244-22a, Aug. 14.

Sisymbrium incisum Engelm. 73-10, July 21.

Raphanus raphanistrum Linn. Wild Radish. 121-23, July 13; 208-23, July 20; 385-23, Aug. 3.

ORPINE FAMILY.

Sedum purpureum Tausch. Garden Orpine, Live-for-Ever. 172-23, July 19.

SAXIFRAGE FAMILY.

Philadelphus coronarius Linn. Mock Orange or Syringa. 265-23, July 26.

ROSE FAMILY.

Fragaria virginiana Duchesne. Strawberry. 558-23, Sept. 6.

PULSE FAMILY.

Phaseolus vulgaris Linn. Kidney bean, String bean, Pole bean. 174-23, July 19.

Trifolium hybridum L. Alsike clover. 301-23, July 30.

Trifolium pratense L. Red clover. 383-23, Aug. 3; 469-23, Aug. 14.

Vicia sativa L. Spring Vetch. 182-23, July 19.

WOOD SORREL FAMILY.

Oxalis acetosella L. Wood Sorrel. 459-23, Aug. 13.

Oxalis corniculata L. Lady's Sorrel. 387-23, Aug. 3.

GERANIUM FAMILY.

Tropaeolum majus Linn. Nasturtium. 195-23, July 19; 294-23, July 26; 295-23, July 26; 578-23, Aug. 30; 510-23, Aug. 23; 609-23, Sept. 19; 61-05, Aug. 27; 96-14, Sept. 2.

TOUCH-ME-NOT FAMILY.

Impatiens biflora Walt. Spotted Touch-Me-Not. 324-23, July 31.

BUCKTHORN FAMILY.

Rhamnus alnifolia L'Her. Alder-leaved Buckthorn. 720-23, Sub. 12, Aug. 25; sub. 13, Sept. 10; sub. 14, Sept. 14.

Rhamnus cathartica L. Common Buckthorn. 2-23, June; 29-23, July 3; 211-23, July 19; 367-23, Aug. 3; 375-23, Aug. 3; 378-23, Aug. 3; 382-23, Aug. 3; 386-23, Aug. 3; 388-23, Aug. 3; 460-23a.b, Aug. 13; 591-23, Sept. 5; 604-23, Sept. 14; 36-06, June 20; 611-23, Sept. 19; 615-23, Sept. 24; 720-23, Sub. 15, Oct. 19; 19-08, June 22; 388-22, Aug. 3.

MALLOW FAMILY.

Althaea rosea Cav. Hollyhock. 299-22, Aug. 29; 380-22, Sept. 26. Flowering Mallow. 575-23, Aug. 20.

Malva sp. 500-23, Aug. 18.

VIOLET FAMILY.

Viola tricolor L. Pansy, Heart's-ease. 167-23, July 19.

EVENING PRIMROSE FAMILY.

Oenothera biennis L. Common Evening Primrose. 470-23, Aug. 14.

PARSLEY FAMILY.

Pastinaca sativa L. Parsnip. 170-23, July 19.

VERVAIN FAMILY.

Verbena hybrida. 656-23, Oct. 6.

MINT FAMILY.

Galeopsis tetrahit L. Common Hemp. 362-23, July 31; 154-21 a,b, Aug. 1.

NICHTSHADE FAMILY.

Nicotiana Tabacum Linn. Tobacco. 140-21d, July 25.

Solanum Tuberosum Linn. Potato. 39-21, June 20; 91-21, July 7; 142-21, July 22; 143-21, July 25; 428-23, Aug. 8; 720-23 sub 2, Aug. 26; 720-23 sub. 5, Sept. 10; 348-18, Sept. 5; 349-18, Aug. 10; 17-20, Aug. 20. 3-21 Sub 3, July 22; 2-23 sub. 4a, July 9.

PLANTAIN FAMILY.

Plantago major L. Common Plantain. 28-23, July 3; 66-23, July 9; 86-23, July 11; 229-23, July 23; 225-22a, Aug. 9.

GOURD FAMILY.

Cucumis sativus L. Cucumber. 169-23, July 19.

Cucurbita maxima Duchesne. Squash. 420-23, Aug. 7; 584-23, Sept. 4; 643-23, Oct. 3; 649-23, Oct. 3; 685-23, Oct. 3.

COMPOSITE FAMILY.

Arthemis cotula L. May-weed, Dog Fennel. 118-23, July 13; 207-23, July 20.

Arctium minus Bernh. Common Burdock. 372-23, Aug. 3.

Bidens frondosa L. Beggar-ticks. 78-23, July 11; 329-23, July 31; 35-19, Aug. 26.

Callistephus hortensis Cass. China Aster. 186-23, July 19.

Chrysanthemum leucanthemum L. Ox-eye or White Daisy, Marguerite or White-weed. 373-23, Aug. 3; 380-23, Aug. 3.

Cnicus arvense (L) Scop. Canada Thistle. 390-23, Aug. 3.

Dahlia variabilis Desf. Dahlia. 201-23, July 19.

Gnaphalium uliginosum L. Everlasting. 376-23, Aug. 3.

Helianthus annuus L. Common Sunflower. 166-23, July 19.

Helichrysum bracteatum Andr. Everlasting. 191-23, July 19.

Leontodon autumnalis L. Fall Dandelion. 247-23, July 24. 379-23, Aug. 3; 210-23, July 20.

Matricaria suaveolens (Pursh) Buchenau. Pineapple-weed. 93-23, July 11; 217-23, July 20.

Tragopogon porrifolius L. Salsify, Oyster-plant. 168-23, July 19.

Zinnia elegans Jacq. Cultivated. 165-23, July 19.

CONTROL MEASURES.

Destruction of buckthorn. It may seem a ruthless proceeding to kill out one type of vegetation for the sake of another, yet all sorts of weeding practices are means to just that end. If a man wishes especially to cultivate healthy and clean nasturtiums, a buckthorn hedge in the vicinity is a row of weeds which harbor nasturtium aphids during the winter months. If a man's fortunes are centered on the production of certified seed potatoes, why increase the expense and difficulty of the operation by planting a hedge of shrubs necessary to the life cycle of an aphid known to be a carrier of potato diseases? Of course there will be circumstances that make the destruction of buckthorn impracticable but in many localities this would probably be the simplest, least expensive, and most effective method of controlling the buckthorn aphid.

Treatment of buckthorn. In situations where the destruction of buckthorn is not possible or desirable, it may still be important to keep down the numbers of the buckthorn aphid by combative methods. Two thorough sprays in the fall (the last week in September followed by another two weeks later would approximate the best dates for Maine conditions) should kill the majority of the oviparous females and thus hold down the number of overwintering eggs. A spring spray (before the middle of June in Maine) should kill most of the spring aphids before migration to the summer food plants begins. For such sprays kerosene emulsion or nicotine sulphate could be used; or if dusting is desired a nicotine dust. Fumigation should be even a more effective method. Fumigation tents could be run on a cooperative basis by a community, and buckthorn fumigated as are citrus trees in the south, or as nursery stock is treated.

Treatment of summer foodplants. A glance at the list of summer foodplants will impress any one with the impossibility of breaking the cycle of the buckthorn aphid by weeding out its accepted summer vegetation. Under some conditions certain of the plants could be sprayed, dusted, or fumigated and the aphid infestation thus sufficiently held down to prevent excessive feeding injury to the plants. Where, however, the aphid is feared not primarily because of its direct feeding injury but because of its role of disease carrier (as in a potato field) there would seem to be no possible summer treatment to prevent vegetation grown in the open from becoming enough infested to lay it liable to innoculation with disease. The spring migrants from buckthorn are flying over to the summer foodplants for a considerable period. By the time this flight has ceased the first of the winged dispersal forms on the summer foodplants are ready to "carry on." There would be no guaranty for an aphid-free plant not grown under aphid-proof screen and the practical limits of such a control would be narrow.

EXPERIMENTAL WORK.

As would be expected with so common a species, this aphid was met in my early Maine collections. I took it on buckwheat and on nasturtiums in 1905. In 1906 and again in 1908, I collected it from buckthorn. In 1910 while working with an aphid that migrates from plum trees to water plants *(Rhopalosiphum nymphaeae)* I found the leaves of water plantain colonized by both species of aphids. I did not at that time know that the collections made from buckwheat, nasturtium, buckthorn and water plantain were the same species; and as I could not definitely identify the water plantain aphid with any known species I named it as a new species—*Aphis abbreviata.* It was not until the summer of 1923 that circumstances were favorable for the experimental work with the buckthorn aphid which settled the bewildering question as to whether for 18 years I had been finding a great many very similar species of aphids on different plants or whether I had been finding one exceedingly variable species on a very wide range of summer vegetation.

TRANSFER FROM BUCKTHORN TO ARROWHEAD, WATER PLANTAIN AND PICKEREL-WEED.

June 25. Seven winged females ("migrants") were collected from buckthorn and caged over arrowhead.

June 28. Twenty-two young feeding on arrowhead.

June 30. Young taking on a yellowish color.

July 2. Young still thriving and one wingless female had matured and given birth to one young.

July 3. The mature wingless female of day before gave birth to 5 more young between 5 P.M. and 7:30 A.M. This individual mounted under the number 2-23 sub. 1A. This, a daughter of a migrant, represented the first generation on the summer foodplant. On this date 4 more wingless females had matured and one of these was giving birth to young.

July 5. Nineteen mature wingless females present, feeding, and accompanied by vigorous colonies of yellowish young.

July 6. Aphids divided, part being given fresh arrowhead and part caged with a choice of arrowhead and water plantain.

July 9. Good colonies on both the water plantain and arrowhead.

July 10. Many of the young were observed to have wing pads.

July 11. Winged females beginning to mature. Removed 3 winged and 2 wingless females from arrowhead and mounted as 2-23 sub. 1B. Removed 2 winged and 1 wingless females from water plantain and mounted as 2-23 sub. 1C.

July 28. Stem of pickerel-weed was placed in vial with arrowhead.

Aug. 11. The aphids had deserted the withering arrowhead for the pickerel-weed and had colonized that in splendid shape.

Aug. 24. The colony in successive generations had lived in cages since June 25. The test was discontinued on Aug. 24.

TRANSFER FROM BUCKTHORN TO POTATO.

June 26. Twenty winged females ("migrants") were collected from buckthorn and caged over potted potato.

From June 27-July 7 daily observations showed that the migrants fed on the potato and stocked it with a good colony of young which also fed and thrived. The first wingless females matured July 5. On July 9, five newly developed winged females were observed and last instar young with wing pads were present.

Besides the transfers recorded in the foregoing paragraphs, transfer tests were made with about thirty other species of plants taken from a wide botanical range. These were kept under observation only long enough to see whether the young produced by the migrants actually fed on the caged plant. As these tests were not carried through one whole generation no record of them has been preserved, the tests serving only as a check on observations of summer colonies found in the open, established in the vicinity of buckthorn hedges.

THE NAMES OF THE BUCKTHORN APHID.

No one can have read to this section of the paper without a query as to why an insect, indicated as of world wide distribution and with a list of food plants including cultivated species, many of which are of economic importance, is apparently making its first appearance in economic literature.

As a matter of fact this is more apparently than really a first appearance, for there can be no doubt that the buckthorn aphid has been found again and again on one and another of its numerous summer foodplants, and that there is a very good reason, nevertheless, why it has not been advertised as a common pest. This reason is that instead of being known under one name the insect in question has been masquerading under many pseudonyms. Thus instead of concentrating the reports under one heading, the scores against this aphid have been scattered under so many different names that the time has not yet come for a reckoning.

It is not the purpose of this paper to straighten out the synonyms involved. I have attempted only to make sure that the facts here recorded of the buckthorn aphid all apply to the one species indicated. I have used the name *Aphis abbreviata,* thinking that until the species has been given further study in other localities its Maine data could most appropriately be assembled under its Maine name. It was described under this name,[8] eleven years before I had evidence that the insect summering on water-plantain migrated from and to buckthorn, its overwintering host-plant.

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[8] Patch, Edith M. Aphid pests of Maine. Me. Agric. Exp. Sta. Bul. 202. 1912. See p. 170-171, and fig. 288-290.

I believe this to be the same species as that published under the name *Aphis solanina* Passerini by Mr. Theobald,[9] which would indicate that the species has been collected from potato since before the time of Passerini's publication in 1863. But little would be gained by using Passerini's name if later it should be proven that *"Aphis solanina"* is the same species previously called *Aphis frangulae*[10] by Kaltenbach and by Koch. For the present purpose then, *"Aphis abbreviata"* will serve. This name will fall as a synonym in time, and how many other names await the same fate in this connection it would be folly to guess. But when the buckthorn aphid stands shorn of all its pseudonyms its economic status will doubtless be found to assume larger proportions than we have previously suspected; for one species will have to plead guilty of the injury done by what we have interpreted as many different species,—each such interpretation being chrystalized by a different name.

It is the opinion of the writer, too, that the buckthorn aphid, when on its summer foodplants, has often been mistaken for the melon aphid *(Aphis gossypii)* and that it has been much confused with that species in entomological collections and literature.

DESCRIPTION OF THE BUCKTHORN APHID.

See also figures 6, 7, 8, all drawn to the same scale.

Color: In general it may be said that the wingless forms vary through different shades of green and of yellow. The early spring forms on the buckthorn are green and those colonies summering on the buckthorn are green or yellowish green. On other summer foodplants, the wingless females are green, yellowish green, or yellow. Usually a given colony will run rather uniformly in color and not present any such motley appearance as is common with *Aphis gossypii*. During the summer of 1923 green summer colonies were found on plantain, fall dandelion, buckwheat, wild buckwheat, chickweed, pigweed, nasturtium, dock, spotted touch-me-not, charlock, beggar-ticks, arrow-leaved tear thumb, common hemp, Japanese barberry, water plantain, arrowhead, squash, potato, wood sorrel, mallow, buttercup, cultivated strawberry and shepherd's purse. Yellowish green or greenish yellow colonies were found on knotweed, rayless mayweed, alsike clover, red clover, burdock, ox-eye daisy, everlasting, fall dandelion, sorrel, yellow wood sorrel, beet, and evening primrose. Distinctly yellow colonies were found on dock, lamb's quarters, wild buckwheat, sunflower, pansy, field sorrel, buttercup, cucumber, parsnip, sacaline, cultivated aster, common smartweed, shepherd's purse, purslane, squash, and potato.

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[9] Theobald, Fred. V. The Aphides attacking the potato. South-Eastern Agricultural College Wye. 1922.

[10] Van der Goot, P. Beitrage zur kenntnis der Hollandischen blattlause. 1915. See p. 196.

Late in the season, the last generation of wingless females to appear on the summer foodplants are found to have two distinct color characters. These are found in the same colonies. The individuals of one series are clear green with pale green young (nymphs) visible through the body wall of the abdomen. These pale green nymphs after birth develop into the winged females that function as fall migrants flying to the buckthorn there to give birth to the egg-laying generation. The individuals of the second series are very dark green, by far the darkest to appear at any time during the season. Their color is deepened by the dark color of the unborn young showing through the body wall. These nymphs with amber-colored head and very dark green abdomen are the young males that develop wings and fly back to the buckthorn in time to mate with the oviparous females. The color distinction between these two series of fall females is very striking.

The oviparous females, developing on the buckthorn leaves, are yellow. The eggs which they deposit are first green, soon turning black.

All the wingless forms have pale antennae, cornicles and cauda. The legs are pale and the feet dark. In the older individuals the very tips of the cornicles and the distal portion of the antennae become dusky. The beak is pale with last segment dusky.

The winged forms, whether spring migrants, summer dispersal forms, fall migrants or males all, so far as the observations of the writer go, have green abdomens, though those of the males are so dark a blue-green that, as the individual ages, it appears nearly black. The head, and thoracic lobes of the winged forms are black. The distal part of the antennae and the cornicles are dusky to near-black, but not the jet black of *gossypii* or *pomi*. The coxal segment and feet are dark, the tibial segment pale with dusky distal portion. The cauda and anal plate are dusky to dark. The wing-veins in both fore and hind wings are all well defined. There is a black spot on the abdomen at the base of the cornicle and 3 lateral black spots anterior to the cornicle.

The last instar of the nymph which develops into the fall migrant has a pale green or yellowish green body. The last instar of the nymph which develops into the male has a dark olive green or almost black body. In both forms the dorsal thorax is whitish, the tips of the wing-pads are dusky, and there are transverse rows of 4 white powder spots each, on the abdomen.

Size: See figure 7 for details of nine mature wingless viviparous females all drawn to the same scale to indicate range in size. See figure 6 for size range in the winged viviparous females.

Of the wingless females 976 were examined. The largest individual (2-23B) measured 2.15 mm from vortex of head to cauda and had an antennal length of 1.4 mm. This specimen and 2-23A were collected from buckthorn and represent the second buckthorn generation, being progeny of the stem-mother. Aphid 235-23 (body length 1.3 mm and antennal length 0.8 mm), was the smallest individual from a bred colony (descendants of migrants collected on buckthorn) reared for several generations on arrowhead and then transferred to buttercup. Aphids 2-23 sub. 1 G I (body 0.97 mm and antenna 0.72 mm) and 2-23 sub. 1 G II (body 1.67 mm and antenna 1.1 mm) were bred descendants from buckthorn migrants reared first on arrowhead and then the later generations on pickerel weed. Aphid 320-23 (body 0.93 mm and antenna 0.5) was the smallest of a colony collected from dock. Aphid 329-23 (body 1.02 mm and antenna 0.52 mm) was the smallest of a colony collected from beggar's tick. Aphid 381-23 (body 0.8 mm and antenna 0.5 mm) was the smallest in a colony collected from sorrel. The three latter specimens have a 5-segmented antenna which is quite common among the summer generations. It will be noticed that the largest individual measured 2.2 mm and the smallest 0.8 mm, a much greater difference than was found with the winged forms.

Of the winged forms 520 were examined. These had a size range of from 2.37 mm body length with an antennal length of 1.32 mm to 1.5 mm body length with an antennal length of 0.85 mm.

Structure: As in many species of aphids there is considerable structural variation. During the preparation of this paper a total of 1496 specimens were given microscopic study. The variations indicated in the drawings and description were for the most part found both among reared colonies (progeny of migrants from buckthorn bred in cages) and in collected material.

The antenna of the wingless viviparous forms is composed of five or six segments. The stem-mother (the first spring generation hatching from the overwintering egg) was not collected, as study with this species was undertaken too late in the season to obtain this first buckthorn generation.[11] The wingless females of the second buckthorn generation have a 6-segmented antenna (Fig. 7, 2-23A and 2-23B). For the most part the summer forms have also a 6-segmented antenna (Fig. 7. 235-23. 2-23 sub. 1 G I and II) but very frequently individuals in the summer colonies will have 5-segmented antennae and in some collections this number will predominate. (Fig. 7. 320-23. 329-23, 381-23 and 2-23 sub. 1 E). The 5-segmented antenna is not correlated with the smallest size of the aphids as many specimens as small have antennae with 6 segments. Whether certain summer generations consistently have antennae with 5 segments or whether this variation is more haphazard in its appearance, I do not know.

The oviparous female (the last fall generation on the buckthorn) has a 5-segmented antenna. (Fig. 8, 615-23).

The winged females, whether the spring or the fall migrants or the summer dispersal forms have a 6-segmented antenna. See Fig. 6. The variation in the number and arrangement of the secondary sensoria is great enough to confuse any one trying to run down this species in an aphid key. There are always sensoria on segment III and these are usually unequal in size. In the specimens reared and collected during 1923, the number of sensoria on this segment ranged from 6 to 16. It is not likely that a single season in a single locality would reach the possible limit of this range. Segment IV is usually with sensoria though there are rare exceptions.

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[11] See page 48.

The drawings in Fig. 6 are fair representations in this respect. It will be noticed that a single individual (604-23) has 8 sensoria on segment IV of one antenna and 3 on IV of the other. It is very common to find a difference in the left and right antenna of the same individual though the difference is usually not so great as this.

Secondary sensoria may or may not occur on segment V. Their number, size, and arrangement is subject to variation.

One "intermediate" (a wingless individual having certain structural characters of the winged form) was taken in 1923—the only "intermediate" out of the 1496 aphids studied. This had a 6-segmented antenna with 5 sensoria on III and one on IV. See Fig. 8, 203-23.

The antenna of the male is characterized by a greater number of sensoria than is found in that of the winged female. Segment VI may or may not have secondary sensoria. See Fig. 8, 609-23 and 720-23 sub. 13.

The tibia in this species possesses no distinctive characters. Four are shown in Fig. 7 together with antenna from the same individuals to indicate the comparative length on the tibia in relation to the antenna. The tibia of the male is usually without sensoria (Fig. 8, 720-23 sub. 5) but one was found with a well defined sensorium near the distal end (Fig. 8, 720-23 sub. 13). The tibia of the oviparous female is much enlarged and thickly set with sensoria (Fig. 8, 615-23).

The cornicles are of the ordinary type of the genus *Aphis*. Like most species of this genus they are subject to a considerable variation in length and a key based upon the relative length of cornicle with reference to segment III or IV of the antenna would be a bit difficult to follow.

The cauda of the buckthorn aphid proved an interesting structure. Normally this has 3 or 4 pairs of lateral hairs in all the forms studied (winged and wingless viviparous females, oviparous females, males, and last instar nymphs). The most common variation in the approximately thousand and a half individuals examined was a cauda with 3 hairs on one side and 4 on the other. Certain collections had more caudas of that sort than those having both sides uniform. When the cauda has three pairs of hairs it resembles the cauda of *Aphis gossypii* more closely than any other though the hairs of the buckthorn aphid are not quite so strong and long as those of the other species. Collections of *Aphis gossypii* frequently contain individuals with but 2 pairs of caudal hairs and this number is sometimes, though very rarely, found on specimens of the buckthorn aphid. More rarely still a cauda is found with 5 pairs of lateral hairs. An even more unusual variation is that where besides the 3 or 4 lateral pairs a mesal pair occurs. Examples of all these variations are shown in Fig. 8.

The first spring generation: While this bulletin was in page proof, collections of the first spring generation (stem-mothers) of the buckthorn aphid were made. Mature specimens were taken May 24, 1924. On June 4 the stem-mothers were still present and producing, although by this time the individuals of the second generation were maturing, including both wingless and winged forms. The colonies crowded the stem and leaves, the latter being twisted and distorted as a result of the infestation.

The stem-mother is colored like the green wingless females of the later generations, with pale cauda and cornicles. The individuals of this first spring generation take on a yellowish green tinge as they become aged. They are, in general, larger bodied than their wingless daughters; but they are most easily distinguished by their shorter legs and antennae. The antenna has five segments, and the base of the fifth segment is about three-fourths as long as the filament. The filament is about the same length as the fourth segment, being conspicuously shorter than the filament in all the later generations.

ACKNOWLEDGMENT.

An entomologist must need tread carefully when approaching the complicated territory of the plant pathologist; and to Dr. Donald Folsom and Dr. Warner J. Morse thanks are due for help on that part of this bulletin that discusses the relation of aphids to plant disease.

A field assistant showing a keen interest in the quest, contributes materially to the work of the investigator; and it gives me pleasure in this connection to mention the services of Miss Edith Merchant.

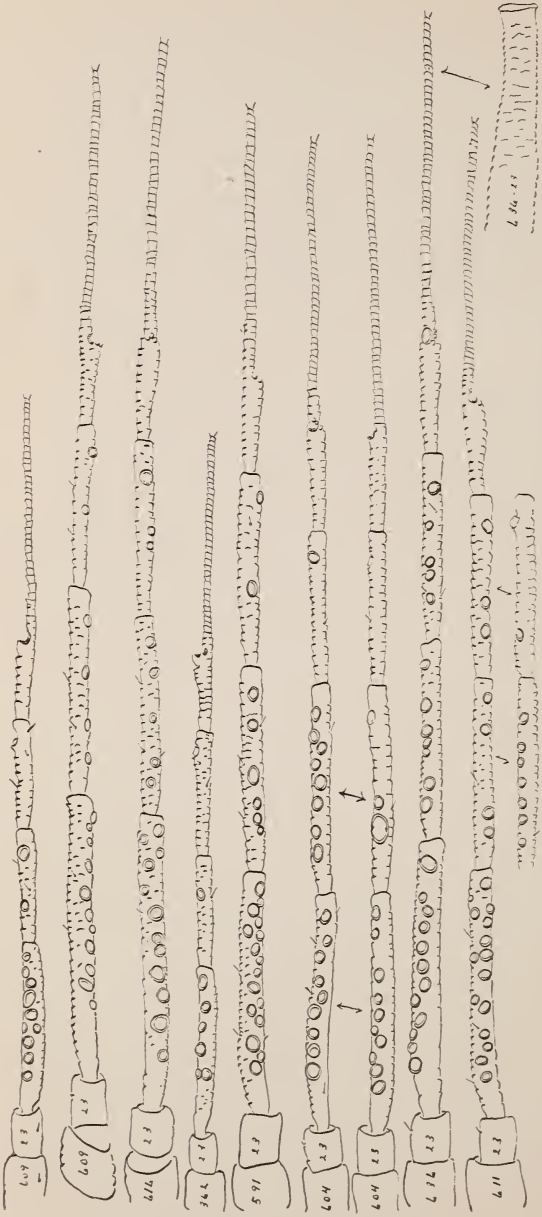

FIG. 6. Antennae of winged viviparous females, and a cornicle. 609-23 antennae from two individuals, one with a body length of 1.5 mm, and one with body length of 1.92 mm. These were collected from cultivated nasturtiums Sept. 19. 616-23 was from Shepherd's purse Sept. 26. 362-23 was from common hemp July 31. 591-23, 604-23 and 611-23 were fall migrants taken from buckthorn in September. These fall migrants exhibited great variability as to the number and arrangement of sensoria. Notice 604 and 611 each showing right and left antennae of same individual. 636-23 from dock Sept. 29.

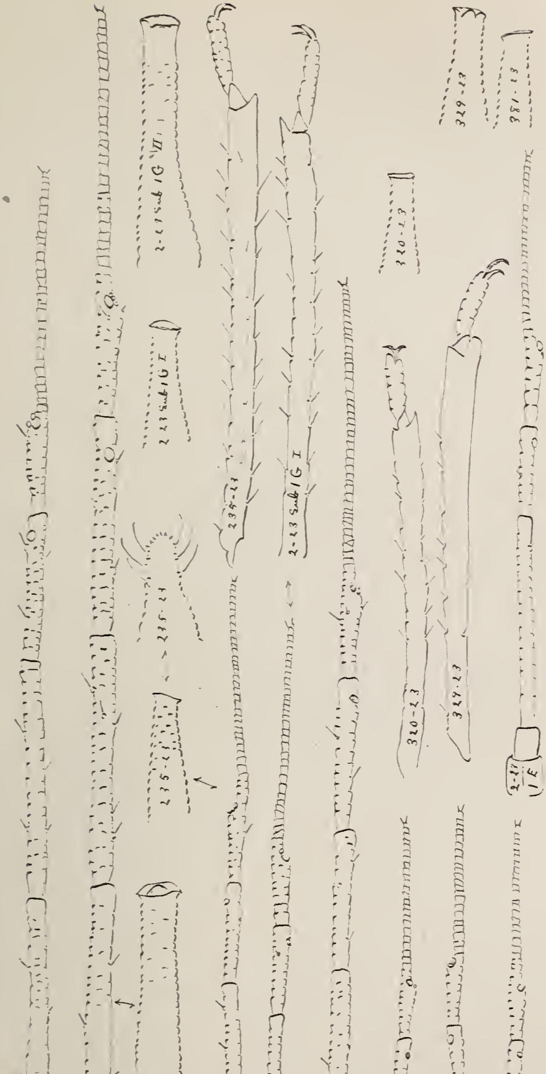

FIG. 7. Details of wingless viviparous females. 2-23 sub. 1E, 2-23 sub. 1G and 235-23 were laboratory-reared descendants of migrants from buckthorn, the first were reared on arrowhead for several generations; the second had the same treatment in the beginning and were later transferred to pickerel weed; the third, after being reared on arrowhead for several generations, were transferred to buckthorn.

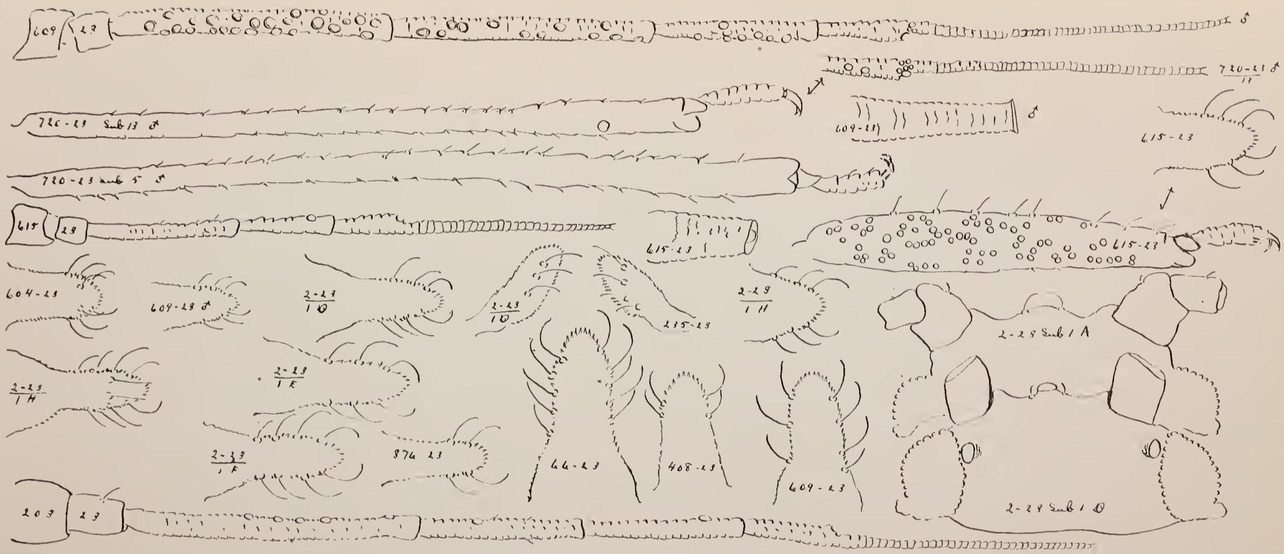

FIG. 8. 609-23 antenna and cornicle of male. 720-23 sub. 5 normal tibia of male, sub. 13 tibia of male with distal sensorium. 615-23 details of oviparous female. 203-23 antenna of "intermediate". (see p.). Lower right hand, head of wingless (sub. 1A) and winged (sub. 1D) viviparous females. Caudas as follows:—615-23 (normal) and 604-23 (with mesal pair of hairs) of oviparous females; 609-23 of male; 2-23 sub. 1D dorsal and lateral view of two winged females reared in same colony; 235-23 lateral view of cauda of winged female with 4 pairs of lateral hairs; 2-23 sub. 1H of last instar nymph and of winged female (with mesal pair of hairs); 2-23 sub. 1E, 2-23 sub. 1F, 376-23, 66-23, 408-23 and 609-23 (lower row) of wingless viviparous females.